

THE MUTATION OF WRITING HABITS AND WHAT IT MEANS FOR L2 WORD LEARNING

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Abstract

Although applied linguists agree that developing phonological and orthographic representations of new words is key to recalling word form and underpins the ability to process new language, research on the mnemonic benefits of writing down target words during L2 vocabulary acquisition has produced mixed results [1, 2, 3]. In addition, writing is facing increasingly keen competition from typing in the digital age. Today, paper-and pencil communication has had to make room for key-to-screen communication in educational as well as professional contexts. From research in educational psychology we know that taking notes on laptops instead of writing longhand involves shallower information processing which negatively affects performance on knowledge tests [4]. In the case of L2 word learning the phonological and orthographical processing that takes place when noting down new words might be sensitive to variations in the conditions under which this processing takes place, i.e. writing versus typing. In our study a classroom experiment was set up to look into the differential impact of writing or typing new words on immediate and delayed receptive and productive vocabulary knowledge as compared to a word learning condition that involved no production of output. The main goal of the study is to verify findings concerning the trade-off relation between semantic and structural processing when learning new words. A second research question is to investigate whether the structural elaboration processes that take place when writing new words lead to similar learning gains than when typing new words. Thirdly, we want to explore whether learners had a preferred learning condition. The main results of this study show that the words that had been typed showed less attrition in the delayed test than the words that had been written. This will be explained in light of the multimodality of the output condition.

Keywords: Vocabulary learning, structural elaboration.

1 INTRODUCTION

Although vocabulary scholars agree that incidental vocabulary learning needs to be supplemented with deliberate form-focused learning if learners are to use new vocabulary productively, the vote is out on the most efficient kind of deliberate and form-focused learning. In theoretical as well as applied approaches to memory, the notion of elaboration is central. According to Levels of Processing theory for example, the discriminability of a memory trace depends upon the degree of elaboration: more extensive or elaborate processing of stimuli is associated with greater retention [5]. In short, within cognitive psychology it is widely accepted that what you remember is determined by the way you process the input.

In the case of vocabulary acquisition, researchers have championed a combination of semantic and structural elaboration for word learning to be most effective. Semantic elaboration refers to associations that are made with the meaning of a new word (e.g. thinking of synonyms of a word) whereas structural elaboration is directed towards the processing of the form of a new word (e.g. paying attention to the pronunciation of a word). In an L2, vocabulary learning is about learning new word forms for concepts that are already known. Initial word learning is therefore defined as the mapping of a new word form onto a meaning and vice versa. Unfortunately, language learners seldom pay attention to the formal aspects of language spontaneously. Once they have summoned up the meaning of a new word, they no longer feel urged to take the word's form to heart. This is known as the Primacy of Meaning principle [6]. Unfortunately, a lack of structural elaboration will probably result in poor encoding of word form, which means that the learner will not be able to retrieve the new word form from memory.

The last decade several vocabulary scholars have proclaimed the need for more research on structural elaboration techniques in L2 vocabulary acquisition. Research has tended to semantic elaboration much more than to structural elaboration, focusing on the successful recall and retention

of word meaning [7]. The same emphasis holds true for the reality of classroom activities: a wide plethora of exercises are directed at semantic elaboration (semantic mapping, looking for synonyms, making sentences, etc.), whereas activities involving structural elaboration are underrepresented in vocabulary course books. This is to be explained by the fact that the development of exercises based on the meaning of words gives a lot more opportunity for variation than the development of activities that involve form.

Nevertheless, developing phonological and orthographic representations of new words is key to recalling word form and underpins the ability to process new language. In this regard a few scholars have looked at the impact of copying or writing down words on the retention of new L2 vocabulary [2, 3, 8, 9]. Writing is essentially a process of productive control of linguistic symbols but the activity also involves phonological decoding of the unknown prompt. Writing thus strengthens the formation of orthographical representations [10] and in many languages orthographical knowledge is intimately tied to the phonological characteristics of a word. However, Barcroft [2, 3] holds that the limited processing capacity of individuals precludes them from allocating processing resources towards different types of learning tasks simultaneously. In his studies attention to the word's formal features when writing depleted the cognitive resources available to attend to a word's semantic properties.

In this paper we report a classroom experiment that was set up to look into the differential impact of writing or typing new words on immediate and delayed receptive and productive vocabulary knowledge as compared to a word learning condition that involved no production of output. The main aim of the study is to verify earlier findings concerning the trade-off relation between semantic and structural processing when learning new words. A second goal was to investigate whether the structural elaboration processes that take place when writing new words lead to similar learning gains than when typing new words. The decision to include a typing condition in the design was inspired by the current debate in schools and universities around the world concerning the shift from paper-and-pencil to keyboard-to-screen communication. Studies such as those by Thurlow [11] and Rosen et al. [12] discuss the influence of text-messaging and typing on formal writing or the impact of digitalization (i.e. the use of messaging, facebook, blogs, tweeting) on informal writing, but they remain silent on the cognitive impact that typing may exert when it comes to forming phonological representations of new L2 words. The shaping of letters and words in handwriting involves kinesthetic processes that differ markedly from the kinesthesia involved in tapping keys on a keyboard. These sensori-motoric differences may play a role in the perceptual and cognitive processing of information. Next to that, the rapid ascent of new technologies has radically changed the historical conflation of reading and writing. While writing and 'reading what you write' is based on the sharing of the same space (i.e. paper), typing separates the reading/writing process since we type on the keyboard and read on the screen. The consequences hereof on our cognitive processing of information are still under debate.

2 LITERATURE

2.1 L2 studies on the effect of writing on L2 vocabulary learning

Studies into the effect of writing on L2 word learning have produced inconclusive results so far. Thomas and Dieter [1] investigated the effects of writing practice and pronunciation practice on the acquisition of L2 vocabulary, including orthography and found that writing (copying) novel words enhances memory for them. They noted that "the act of copying clearly draws attention to the structure of the word... [and] may result in a separate motor trace in memory that also assists in retrieval" [1, p. 252]. Learning experiments that were reported by Webb [13], Folse [14] and Pichette et al. [15] demonstrate that writing new words in sentences is more beneficial for word learning than reading new words in sentences.

However, Barcroft's studies [2, 3] cast a different light on the affordances of writing. In his studies of word-picture associations with English-speaking learners of Spanish, writing a word in the initial stage of word learning hindered the establishment of form-meaning connections and detracted from the ability to recall the words. Barcroft's Type Of Processing-Resource Allocation (TOPRA) model illustrates learners' inability to allocate processing resources toward different types of learning tasks simultaneously and is consistent with Van Patten's [6] theory on the limited processing capacity of language learners. The TOPRA model holds that semantic elaboration will increase the learning of meaning while it will inhibit word form learning by depleting processing resources that could have been spent on new word form. Vice versa, structural elaboration will increment word form learning while impeding meaning learning by exhausting the attentional resources that could have been directed at

encoding meaning. Xu et al. [16] reported a similar trade-off relation in a study that involved a comparison of character writing and animation with reading as a means of character learning in English speaking learners of Chinese. Writing led to better form recognition and cued recall but poorer meaning recall compared to the reading-only condition. Stengers et al. [8] designed a study to assess the merits of adding a copy exercise to an existing online idiom-learning tool in order to render the tool more form-oriented. They found that the copy-condition did not foster a higher uptake of the precise form of the target lexis than its more semantic-oriented comparison condition. Although the participants' relatively high level of language knowledge in this study may have played a role in the (lack of) effectiveness of the added copy exercise, once again the presumed beneficial effect of copying exercises was contradicted by the data. Finally, in a study in which word writing was contrasted with meaning inferencing in a contextualized word learning context, Candry et al. [9] attested that the word writing condition benefited L2 word learning more. This study included more written repetitions of the target words than in previous studies, which may have enforced the establishment of motor memory.

2.2 Neurolinguistic and other studies on the processes of writing and typing

Although writing as well as typing are activities that establish a link between the phonology of a new word and its orthography (leading to the development of orthographic awareness of a language), handwriting seems to engage the visual-spatial cortex of the brain more than typing. According to the literature this is to be explained by the different kinesthetic processes: handwriting requires a sequence of movements that shape the characters whereas typing does not require the active engagement with the shape of a letter but the association of a character and a simple motor response [17]. Neuro-imaging has illustrated that sequential finger movements activate massive regions in the brain involved in thinking, language and working memory – the system for temporarily storing and managing information -, which is not the case for typing [18].

Neurolinguistic studies on writing processes have focused mainly on the contribution of writing movements to the development of language representations and how this may influence reading. During reading, word meaning must be rapidly retrieved in response to orthographic strings. The possible role of a motoric component in establishing representations for literacy has been tested with children learning the alphabet for example [19, 20]. On the basis of these studies the researchers proposed that memory representation of letters incorporates visual and motor information across a complex neural network in which Broca's area and areas of bilateral inferior parietal lobes are implicated. Most adult studies on the effects of handwriting on functional brain development also demonstrate that motor knowledge contributes to the visual recognition of letters [21, 22, 17]. As Guan et al. [10] explain it, handwriting establishes neuromotor memories for characters because writing provides a mental model of the written form that is accompanied by a new neural motor memory. Brashers-Krug et al. [23] hold that these motor memories – if they become stabilized – can last for a very long time without any further practice. In psycholinguistics, Perfetti & Hart [24] developed the Lexical Quality Hypothesis that explains how precise lexical orthographic representations resulting from handwriting mediate the further development of phonological representation and integrate these with lexical-semantic representations.

With regard to the differences in cognitive processing of writing and typing, Longcamp et al. [19] found a stronger activation of the left Broca's area for handwritten characters than for typed characters. They emphasize that consolidation processes are dependent on motor modality. In their behavioural studies Longcamp et al. [25] demonstrated that letter recognition benefits from handwriting practice more than from typing practice. Neuro-imaging in both adults and children pointed out that handwriting is important for letter processing in the brain because writing involves the recruitment of letter-specific neural processing regions. In a comparative recognition study of handwritten and typed scripts, Manso De Zuniga et al. [22] was able to show that handwriting affected the rate of lexical access positively.

Other - more behavioural - studies report that students prefer reading on paper to digital reading [26] and that students experience handwriting as a more multi-sensorial experience than typing, with many students emphasizing the uniqueness of their handwriting and how this helps them memorize [27]. In short, from the literature on this topic we infer that the kinesthetic processes involved in handwriting seem to aid in memory encoding and retrieval, which suggests a possible motoric component to lexical representations.

2.3 SLA studies on the differential impact of writing and typing

To our knowledge, the only SLA studies that have been published about the differential effect of typing or handwriting concern the use of diacritics. Gascoigne [28] reported that first-semester learners of French and Spanish were better able to place accent marks accurately on a handwritten dictation post-test if they had practised the texts using a computer keyboard than if they wrote them out by hand. This was found to be true irrespective of the participants' self-reported preference for writing their L2 by hand, in both French and Spanish. This advantage was attributed to the increased psychomotor movement that is required in typing the accented letters (situated at a different place on the keyboard than their non-accented equivalents) which may have led to better retention of accent mark placement and therefore better performance on the post-treatment dictation. Sturm [29] examined Gascoigne's claim that psychomotor movement had led to increased recall of accent marks by dividing first-semester French students into three groups: handwriting, typing using alt+ numeric codes for accented letters, and typing using one keystroke (pre-programmed F-keys) to make accented letters. They found no significant differences between the conditions. To our knowledge no studies have been published in which writing and typing are put to the test as independent variables in L2 word learning.

3 EMPIRICAL STUDY

In this study we will look into the effects of different forms of structural elaboration on the retention and recall of new L2 vocabulary. The different forms of structural elaboration we wish to explore are copying the target word through handwriting and copying the target word through typing. We have partially replicated Barcroft's [2] study. In his study he found negative effects for word writing in an experiment in which participants attempted to learn 24 new word-picture pairs. In the Copying condition, learners wrote the words down and in the No output condition learners looked at the word-picture pairs on the screen. The higher scores on the cued recall post-test for the words learned in the No output condition led to the development of Barcroft's Resource Depletion for Output Hypothesis [RDOH, 2, p. 495], in which he postulates that word writing exhausts cognitive processing resources that could be used to encode new word forms and establish new form-meaning mapping.

For our study we will use a similar research design in which decontextualized words (largely the same words as in Barcroft's study) are learned under different conditions. In contrast with Barcroft, three instead of two conditions will be implemented (No output, Writing and Typing). Since word learning involves storing words in long-term memory, the participants' knowledge of the target words will not only be tested after the learning phase but also one week later.

3.1 Research questions and hypotheses

Based on the reported literature we can assume that writing and typing will foster the development of lexical representations. Therefore we predict that writing and typing will result in higher scores on a productive recall test. Because writing engages the visual-spatial cortex more than typing, we predict higher scores for writing in the productive recall test. Along the lines of Barcroft's RDOH hypothesis, we predict that typing as well as writing should negatively affect form-meaning mapping. We therefore hypothesize that the meaning of the words learned in the Writing and Typing condition will be remembered less well than the words that are learned in the No output condition. Again in congruence with the RDOH-hypothesis we predict that the scores in this receptive vocabulary test will be higher for the words learned in the typing condition than for the words learned in the writing condition since writing would have engaged more cognitive processing than typing. We also predict that the delayed tests of receptive and productive vocabulary knowledge will show attrition to the same degree for all three conditions.

3.2 Participants

The participants in this study are 53 Dutch-speaking students learning Spanish as one of two foreign languages in a bachelor's programme in Applied Language Studies. The students' age ranged from 19 to 21 years old, and their proficiency in Spanish was estimated by their respective teachers to be at level B1 of the Common European Framework of Reference. Participants were randomly assigned to one of three groups (respectively called A, B or C).

3.3 Procedure

We chose a within-subject design in which all participants were exposed to all task types (see Table 1). All subjects were invited to learn 8 new words in three different conditions, thereby learning a total of 24 words. This design will allow us to infer that the learning gains are the result of the elaboration technique and not the result of individual differences between the participants or the specificities of the sets of words.

Table 1. Within-subject design of the study.

Target words	Group A	Group B	Group C
Set of words 1-8	write	type	no output
Set of words 9-16	type	no output	write
Set of words 17-24	no output	write	type

The target words in this study are based on the set of words used by Barcroft in his word learning studies [2, 3]. They consist of 24 concrete nouns of different lengths divided into three sets, with the number of syllables per set kept equal. Because of the fact that certain words were expected to be known by the Dutch participants, some of the words had to be replaced by others. However, care was taken that the average number of syllables per set of words was kept equal. The shortest word *asa* counts two syllables and three letters, the longest word *resbaladilla* counts five syllables and twelve letters. There was an average of 3 syllables per word, with a total of 23 syllables in the first set and 24 syllables in the second and third sets (Table 2).

Table 2. Three sets of Spanish target words and their English translations.

Set 1 (word 1-8)	Set 2 (word 9-16)	Set 3 (word 17-24)
serrote (saw)	taladro (drill)	clavija (plug)
regadera (watering can)	alcantarilla (sewer)	resbaladilla (slide)
escoba (broom)	pinza (clothespin)	asa (handle)
rastrillo (rake)	chiringa (kite)	candado (lock)
embudo (funnel)	aletas (flippers)	tenazas (pliers)
muletas (crutches)	columpio (swing)	nadadera (swimming ring)
imán (magnet)	pala (shovel)	hacha (axe)
formón (chisel)	balde (bucket)	gancho (hook)

The students were asked to participate in a word learning experiment and they all gave written consent. Just before the experiment started, the students were asked if they were familiar with the target words. They had no knowledge of any of these words. Next, they were instructed to try and learn the 24 Spanish words presented to them in word-picture pairs. Each word-picture pairs was projected on a screen in the front of the classroom for six seconds. For the 8 words in the writing condition, the students were instructed to write each word down in the blank space next to the image on a form they had been given. For the 8 words in the typing condition, the students were instructed to type each word in the blank next to the image on a website that had been developed. In the control condition the students were told to look at the word-picture pairs closely. When a set of 8 word-pictures pairs was completed, the procedure was repeated once. Immediately after the learning treatment, the students received a productive recall test in which they had to write the appropriate Spanish word next to the corresponding picture. This was followed by a receptive test in which they were invited to write down the Dutch translation next to the Spanish target words. Before the experiment came to a close, they were also asked which of the learning conditions they had enjoyed most and which of the learning conditions they thought was most effective for learning. One week later, a productive and receptive knowledge test of the target words was administered again.

4 RESULTS AND DISCUSSION

As explained in the procedure, four tests were administered in order to measure word learning gain. We will refer to the immediate tests (targeting receptive as well as productive knowledge of the target words) as meaning recall and form recall tests and to the delayed tests (again receptive as well as productive knowledge of the target words) as meaning retention and form retention tests. In the meaning recall and meaning retention tests lenient scoring was applied. For example, if a student interpreted the image of a magnet as a horseshoe, this response was accepted. In the form recall and form retention tests Barcroft's Lexical Production Scoring Protocol was used, which is sensitive to partial knowledge of word form. Scores on all these tests were subjected to a repeated measures analysis of variance (ANOVA) with condition (Writing, Typing, No output) and time (immediate, delayed) as within-subject independent variables and score as the dependent variable. The alpha level was set at .05 for all of the statistical analyses. For these analyses SPSS software was used.

4.1 Meaning recall test

Mean scores were highest for the No Output condition (6.77), followed by the Typing condition (6.23) and the Writing condition (6.17). The results of the ANOVA revealed a significant effect for condition, [$F(2,51)=4.856$, $p=.010$, $\eta^2=.085$]. Pairwise comparisons indicated that the meaning recall in the No Output condition was significantly higher than in the Writing and the Typing condition. Yet, no significant difference was found between the Writing and the Typing condition. This means that the students' receptive knowledge of the target words was aided by the conditions in which they did not produce language, but just looked at the new word form and its meaning (i.e. the picture denoting the meaning).

4.2 Meaning retention test

One week later, mean scores on the receptive test drop by an average of 0.74. Considering the time lapse of one week and the fact that the students had not been given new learning opportunities with the target words, this attrition was expected. Again, means are highest for the No Output condition (5.74), followed by the Writing (5.67) and the Typing condition (5.39). However, an ANOVA analysis only reveals a significant effect of time, [$F(2,49)=24.332$, $p=.000$, $\eta^2=.327$], not an effect of condition, [$F(3,48)=2.419$, $p=0.94$, $\eta^2=.46$], and no other significant main effects or interactions. This means that the words were remembered equally well across conditions. Apparently, the advantage of the No Output condition when it comes to the receptive knowledge of the target words has worn off after one week.

4.3 Form recall test

When it comes to producing the form of the target words, mean scores were highest for the Writing condition (5.73), followed by the No Output (5.19) and the Typing condition (5.06). The results of the ANOVA revealed a significant effect for condition, [$F(2,51)=4.725$, $p=.011$, $\eta^2=.083$]. Pairwise comparisons indicated that the difference is situated between the Writing and the Typing condition, and between the Writing and the No Output condition, both times in favour of the Writing condition. From these results we can infer that the Writing condition led to the best recall of word form. The Typing condition did not offer the same mnemonic rewards as the Writing condition when it comes to reproducing the form of newly learned words nor did it lead to better form recall than when students simply looked at the target words.

4.4 Form retention test

Mean scores dropped by an average of 3.13 when the test was administered one week later, with ANOVA revealing a significant effect of time, [$F(1,50)=305.345$, $p=.000$, $\eta^2=.859$]. Although the scores are highest for the Typing condition (2.27), followed by the Writing condition (2.24) and the No Output condition (2.09), these differences are negligible. This was confirmed by the ANOVA analysis that did not reveal a significant effect of condition, [$F(2,49)=2.130$, $p=.124$, $\eta^2=.041$]. Interestingly, the ANOVA pointed at a significant interaction between condition and time, [$F(2,49)=3.223$, $p=.044$, $\eta^2=.061$]. An ensuing pairwise comparison of the attrition scores showed a significant difference between the Writing condition and the Typing condition. This finding suggests that words that had been typed during the learning treatment were more resistant to decay than words that had been written. The most probable explanation for this finding lies in the multimodality of the encoding that was only the case for the words learned in the Typing condition of

this experiment. Words that had been learned through typing, were written during the immediate test, before being tested again (through writing) one week later. This was not the case for the words learned in the Writing and the No Output condition.

Table 3. Scores on the word learning tests (with a maximum score of 8 on each test)

Test	Condition	Mean	SD
Meaning recall	Writing	6.17	1.62
	Typing	6.23	1.69
	No Output	6.77	1.32
Meaning retention	Writing	5.67	1.72
	Typing	5.39	2.05
	No Output	5.74	1.89
Form recall	Writing	5.73	1.62
	Typing	5.06	1.62
	No Output	5.19	1.59
Form retention	Writing	2.24	1.37
	Typing	2.27	1.31
	No Output	2.09	1.38

4.5 Learner preferences

The participants' responses to the questions about their learner preferences ("what is the most fun way to learn new words" and "what is the most effective way for you personally to learn new words") are listed in table 4. Although it is clear that there are differences in learner preferences, 45% of the participants choose writing as the condition that is most fun. A large majority of learners (74%) believe that writing is the best method for vocabulary learning. Several participants mentioned that writing made them think most about the spelling of the word or pointed out that writing was an active way of concentrating on the word. A small number of students argued that not producing output gave them more time to link the form and the meaning of the words. Especially interesting were the arguments regarding the writing versus the typing distinction. Some students declared that writing is a more conscious process compared to typing. Others stated that when they were typing, they did not always look at the screen, and therefore did not necessarily obtain visual representations of the words.

Table 4. Responses to retrospective questions about learner preferences.

	Writing	Typing	No output
Most fun?	45%	28%	26%
Most effective?	74%	10%	16%

5 CONCLUSIONS

With reference to our hypotheses the empirical study rendered mixed results. We predicted that the meaning of the words learned in the Writing and Typing condition would be remembered less well than the meaning of the words that were learned in the No output condition. This turned out to be the case but only in the immediate test. In the delayed test, the attested advantage of the No Output condition disappeared. Receptive knowledge of the different sets of words was equal across conditions. It turns out that writing or typing words did not detract from form-meaning mapping. This finding points to the importance of replication studies as well as the importance of including delayed tests in language learning studies. After all, learning is supposed to lead to permanent memory storage.

We also predicted that the scores for meaning recall would be higher for the words learned in the typing condition than for the words learned in the writing condition since writing would engage more

cognitive processing than typing and thus negatively influence form-meaning mapping. This was not the case.

With reference to the processing of word form, we predicted that writing and typing would result in higher scores on a productive recall test. This was only the case for written words in the immediate test. Finally, we expected the same degree of attrition in all three conditions. However, the results point to a smaller attrition for the words learned in the typing condition. This is explained in light of the multimodality of the output condition: the words that were learned in the Typing condition were the only ones who were typed and written before the delayed test was administered. Processing the word forms along different modes seems to benefit the retention of word form. The higher form recall for written words combined with the smaller attrition for typed words in the form retention test suggests that practice that orients attention to form privileges form recall more than not engaging in output.

Combined, the data on receptive and productive word learning in this study suggest that writing does not necessarily distract the learner from establishing form-meaning mappings. In language, form and meaning are inseparably connected since forms communicate meanings and meanings are represented by forms. If the form and the meaning of a new word are mapped, they become two sides of the same coin. In classroom practices where learners are encouraged to write down new L2 word forms, they do so in meaningful contexts, which means they engage with the semantic as well as the structural properties of the word. Memory involves storage as well as retrieval and attending to form strengthens the memory trace and makes the form distinctive from other information in memory, which will help retrieve the word. Writing and typing therefore foster the structural elaboration of new words, resulting in better retrieval.

For this study a within-subject design was chosen in which all participants were exposed to all task types. This decreased the possibility of individual differences influencing the results, but it has as a limitation that participants might have transferred the learning strategies they used in one condition to the next.

Finally, in order to solve the question of multimodality and find out whether writing and typing lead to differences in meaning or form retention, a new experiment with counterbalanced task-test combinations needs to be designed. Also, more finely-grained psycholinguistic measures are needed to shed light on the processing differences between writing and typing when learning new L2 words.

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